On the Persian Forms of *Pieris pseudorapae* Vty.

By B. C. S. Warren, F.R.E.S.

In the summer of 1970 the National Natural History Museum of Czechoslovakia sent an entomological expedition to Persia under the control of Dr Josef Moucha, chief of the department of entomology in that Museum. At his request I have been glad to study the specimens of the *napi*-group they captured. They were all *Pieris pseudorapae*. The species was scarce everywhere. All were taken at altitudes between about 500 and 3,200 m. In past years I had seen a few specimens taken by individual collectors, but as always in such cases if a collector takes a few "whites", he selects the finest examples, and this gives one little information as to what the characters of the local race actually are. It was therefore interesting and instructive to get even short series of the insect from three widely separated localities, between the Zagros Mountains in west Iran and a locality 10 km. south of Gorgan in the north-east area, including some from the Shah Mohammed Reza Wild Life Park about 80 km., east of Gorgan. Here they collected from the 27th to 30th of July. A third locality where they found a few specimens was Rubarak in the Caspian region of north Iran. In addition to these there were a few specimens each from four other localities. In all they collected in the country from 1st July to the middle of August. As noted all they took were of the hybrid race *pseudorapae*, easily recognisable by their appearance and the androconial scales.

There were two sizes of the insect everywhere, a medium one (length of forewing 25-28 mm. from the centre of the thorax to the wing tip), and a small one (length of forewing 21-24 mm). I figure the latter as it might be mistaken for *P. rapae*, both in size and absence of markings on the underside of the hindwings; fig. 7 is a heavily marked specimen. All were of the summer generations, and the same type of markings and the same sizes occurred at every altitude and in every locality. Having seen one of the small examples many years ago from over 10,000 ft. in the Mazanderan region of the Elburz Mts. I had wondered if it was a monogenerational form. But we now have proof that both forms fly together at all altitudes in Iran.

EXPLANATION OF PLATE

1. *P. pseudorapae*, summer generation, large type scale.
2. *P. bryoniae*, monogenerational scale.
3. *P. pseudorapae*, first or spring generation form scale.
4. *P. napi*, first or spring generation form scale.
5. *P. pseudorapae*, summer generation, small type of scale.
6. *P. pseudorapae*, male, first generation.
7. *P. pseudorapae*, summer generation, male of small form.

Butterflies natural size.

Scales all × 450 *Photos. B. C. S. Warren.*

In his book on the Lepidoptera of Iraq (1957), Wiltshire states that *pseudorapae* is a mountain species and there are three or four successive generations. In Iran it seems the same is the case. No first generation specimens were found by the expedition even at the highest altitudes. Specimens from overwintering pupae have very broadly spreading markings on the underside of the hindwings, as in fig. 6. The first generation probably flies in May or June at moderate to high levels. In Turkey, at sea level, it is on the wing in March and April. In size the largest form of the insect that I know comes from the Cilician Taurus, but it occurs again in the far east in the Tian Shan. (Length of forewing from centre of thorax 28-31 mm.). The universal presence of two sizes in Persia is remarkable, but even more remarkable is the presence of two types of adroconial scales in specimens of either size. These scale types are obviously connected with the hybrid origin of the insect which in fact they illustrate very strikingly. Doubtless there are some who will not accept these scale characters at their obvious value, and will continue to say *pseudorapae* is a subspecies of *P. napi* and seek to prove this by crossing *pseudorapae* and typical *napi*. I have not the least doubt the two will be found to breed together readily, as *napi* and any other species of the group will, and indeed many species of other groups also will. It is difficult to understarnd how the fact of fertility, which is known to appear in practically every modern experiment, can be advanced as "proof" that all the insects experimented on must be conspecific. It may be recalled that fertility follows most crossbreeding experiments in the Heterocera as well as Rhopalocera. If such fertility were the true criterion of a species how many of our Hawk moths now called species would become races? One may recall the paper by Denso (*Bull. Soc. Lép. Genève* 1905, Vol. I; 84-97). Here he records fertile crosses between *vespertilio, hippophaes, galii, euphorbiae, elpenor* and *porcellus,* and employs at least eight names for hybrid races that have been frequently bred. Of course he was not the only worker interested in such work at that time, and I need scarcely remind readers of the many crosses between *quercus* and *ocellatus* made in this country. Further it is common knowledge that fertility between distinct species occurs not infrequently in wider fields of Zoology also.

The following remarks caught my eye just by chance, but they seem worthy of mention. When looking over Cowards "*Birds of the British Isles*" I noticed he referred to species "breeding together yet remained distinct". Thus the Carrion Crow and the Hooded Crow are said "when their ranges overlap" to cross and are fertile, yet "their striking differences remain distinct" (l.c. Vol. I, p. 23); later with reference to certain "Wagtails", "the birds interbreed and are fertile" (as the two Crows already mentioned) "yet according to the majority these two Crows are specifically distinct" (l.c. Vol. 3, p. 65).

Yet again a year or so ago in an account of the European

and American Bisons, known as *Bison bonasus* (Europe), and *B. bison* (American), I read, "although they cross easily without any loss of fecundity they are today regarded as separate species" (*Oryx*, Vol. 6, p. 18, Augt. 1961).

These are but a couple of chance instances but they show that in the higher branches of Zoology fertility cannot be held to be a faculty limited to conspecific races. Thinking that the frequent references to fertility as "proof" of specific unity must therefore rest on some established facts probably of earlier date, I looked over what Darwin had established on the question. There can have been no past or modern worker who accumulated such extensive data covering so wide a range in Zoology and Botany as he had. One or two notes on his elaborate researches show results that might not have been expected. The following are from the "*Origin of Species*" (6th Edition, Murray's Library, reprinted Feb. 1921).

Here he writes (p. 226), "But the fertility of first crosses is likewise annately variable; for it is not always the same in degree when the same two species are crossed under the same circumstances; it depends in part upon the constitution of the individuals which happen to have been chosen for the experiment". Modern experiments in Lepidoptera certainly support this remark.

A little further on (l.c. p. 227), he writes: "No one has been able to point out what kind or what amount of difference, in any recognisable character, is sufficient to prevent two species crossing. It can be shown that plants most widely different in habit and general appearance, and having strongly marked differences in every part of the flower, even in the pollen, in the fruit, and in the cotyledons, can be crossed. Annual and perennial plants, decidous and evergreen trees, plants inhabiting different stations and fitted for extremely different climates, can often be crossed with ease".

Still further on (l.c. p. 242), "from these several considerations we may conclude that fertility does not constitute a fundamental distinction between varieties and species when crossed".

It is unquestionable that the result of Darwin's lengthy and wide-ranging studies led him to conclude that the presence or absence of fertility was immaterial, of no particular significance in the separation of species and races. I can only conclude that fertility in crosses is so normal a phenomenon that it is its occasional absence that has given rise to the unproveable assumption that " a degree of fertility" is a "proof".

But we must now return to the development of the androconial scales in *pseudorapae*.

The primary fact is that two recognisable types of these scales exist, and that both are transitional between the scales of *bryoniae* and *napi*. Of these two types fig. 1, shows the larger, and fig. 5, the smaller. It may be well to consider the scales of typical *napi* and *bryoniae* first, as there often seems uncertainty about these in spite of the number of times they

have been figured in the past. In *napi* the body of the scale, or basal part, is roughly more circular in form, and the lines of the sides curve in very abruptly to the constriction of the neck, or terminal shaft of the scale. (See fig. 4).

In *bryoniae* the body is more oval, narrower and longer, and the side lines slant in a more gradual curve into the neck contraction (see fig. 2). The actual portion of the neck in which the two side lines are exactly parallel, is slightly longer in *bryoniae* than in *napi*.

The larger of the *pseudorapae* types of scale is larger than in either *napi* or *bryoniae*, with the body less circular than in *napi* and less evenly oval than in bryoniae, and with the sides not infrequently somewhat flattened in places, and the contraction to the neck more as in *bryoniae*. It can be said on the whole that *pseudorapae* scales have the body more as *napi*, but often larger, and the neck more as in *bryoniae*. In the smaller form of scale in *pseudorapae* the body is reduced in size but still of the more circular form, and the neck a reduced *bryoniae* form but long (see fig. 5). The two types of the *pseudorapae* scale are obviously different from each other in development and outline, and neither could be mistaken for the other or for typical *napi* or *bryoniae*. There is of course, as in all androconial scales variatiion, especially in the hybrid insects and some times distortion and lack of symmetrical perfection. For the plate I have selected symmetrical examples. Both are of the summer generations. Fig 3 is a normal first generation type. I have seen another first generation form which is practically wedge-shaped; there is no contraction between the termination of the scale and the broadest part of the body. This is quite a normal type in *P. ochsenheimeri*, and very likely is a result of some chance connection with that species in the past, for *pseudorapae* has an immense distribution. It spreads from one side of Iran to the other and far to the west to the sea, and further still to the east to the Tian Shan, but for some strange reason is not known in Afghanistan.

The scale forms are common to both sizes of the insect in Iran, which is a remarkable example of how distinctly a hybrid race can reproduce compound formations, once it has crossed. From such developments it follows that fertility is but a phase of growth, it is only restricted in operation by physical limitations. An abnormal cross can only produce abnormal offspring, they must, and do, differ in various respects from either parent; an undeniable proof that the latter are not both the same; but this does not stop them growing.

The proces of growth is predominant, controlling every phase of existence, from the absence of perpetual uniformity to the production of the most extreme variant. For this reason the importance of structural change cannot be overestimated, we have only to look at the wonderful changes of appearance achieved by mimetical causes which leave structural formation entirely unaltered. It is such demonstrations of the unity of structure and specific nature, that give one complete confi-

dence in structural characters as guides to the recognition or separation of species. Structure and specific nature have grown as one, united from the start, and should some deviation have arisen, with growth this can only increase and the two become ever further divided. Two structural forms cannot unite again into one, growth can only increase the difference.

Pieris Specimens for Androconia : the end of the "Hybrid Species"?

By S. R. Bowden

Warren (1971) has given an account of events which led him to reject bred specimens for use in his androconial work, and to advise others to do likewise. It will, however, be necessary to go further back, to understand what happened.

I never quite followed Mr Warren in his association of deformed scales with hybridity. I wrote to him (in 1966) that the *bryoniae*×*oleracea* specimens had shown that interspecific hybrids need not have any deformed scales, so that the precise cause of deformation (when it occurred) was rather obscure. I was at that time unable to begin any systematic study of androconia myself, because although the procedures are simple they do consume some time, which was lacking. Nevertheless, it would have saved us all a great deal of trouble if I had pursued the matter then, and I am sorry that I did not.

The precise criteria by which hybrid-type scales are to be recognised have not been entirely clear. Basal prongs tending to an hour-glass shape, combined generally with asymmetry of the whole scale (Warren 1966: figs. 5,9) would appear to be the most characteristic manifestation, others being subject to intuitive interpretation.

In 1970-71 one of my first tasks was to show that other factors besides hybridity could produce scales distorted in this way. I looked at specimens from broods including also partial cripples, and found what I expected. Some of these were hybrids, and some were of subspecies that Warren graded as "hybrid species." To prove my point. I had to find deformed scales in undoubted pure species. This I was able to do most easily by looking at long-retarded "spring" emergences of English *napi*, Lappland *adalwinda* and Swiss *bryoniae*. Although the slides that I then sent to Mr Warren showed many grossly abnormal scales, it was generally possible to find normal ones predominating in brother butterflies.

Perhaps the worst conditions for the development of adult *Pieris* are provided by post-diapause temperatures fluctuating just above and just below the minimum required for imaginal development to continue (ca 6°C ?). Unfortunately refrigerating systems have their de-frosting periods and even temporary failures. Sharp cooling of pupae after the initiation of development can be very deleterious (Bowden 1955). It is possible